

2013 Maryland FMP Report (August 2014)

Section 14. Eastern Oyster (*Crassostrea virginica*)

Oyster abundance in the Maryland portion of the Chesapeake Bay has been improving over the past several years. Based on the Maryland 2013 Fall Oyster Survey, the oyster biomass index has doubled since 2010 and is currently at its highest level since 1993. Low natural mortality and good reproduction in 2010 and 2012 contributed to the increase in biomass. Although disease mortality has been low, it is still prevalent in the population and environmental conditions could trigger detrimental effects.

Chesapeake Bay Oyster Management

The Chesapeake Bay Oyster Management Plan (OMP) was adopted in 1989 and revised in 1994 and 2004. The 2004 OMP provides both a general framework and specific guidance for implementing a strategic, coordinated, multipartner management effort for oysters in the Bay. The OMP defines several strategies for rebuilding and managing native oyster populations: evaluating the use of sanctuaries and harvest reserves to obtain optimum ecological and economic benefits; rebuilding habitat; managing harvest; increasing hatchery production; evaluating the impediments to aquaculture; improving coordination among the oyster partners; and developing a baywide database to track restoration projects. Amendment #1 to the OMP was adopted in 2010. The amendment allows aquaculture and clamming activities within the larger, expanded sanctuary program (areas closed to shellfish harvest and areas with focused restoration activities); the use of new enforcement measures to protect sanctuary areas; and the implementation of sanitation guidelines. The 2004 OMP was reviewed in 2010. The Plan Review Team (PRT) concluded that the framework for managing oysters was still appropriate but that the strategies and actions had changed considerably because of the Maryland 10-point plan. The PRT recommended a complete revision of the plan. However, a timeline for revising the plan has not been developed.

A Maryland Oyster Advisory Commission (OAC) was established in 2007 and continues to provide advice on strategies for rebuilding and managing the oyster population and fishery <http://dnr2.maryland.gov/fisheries/Pages/mgmt-committees/oac-index.aspx>. Maryland is currently implementing a 10-point Oyster Restoration and Aquaculture Development Plan. The plan increases the network of oyster sanctuaries from 9% of available habitat to 24%; identifies areas for oyster aquaculture with a streamlined permitting process; and allows a more targeted, scientifically managed, sustainable public fishery.

The Sustainable Fisheries Goal Implementation Team (SFGIT) of the Chesapeake Bay Program (CBP) established a workgroup to develop quantitative oyster restoration metrics; to define sampling protocols and provide assessment techniques for sanctuary reefs. The group completed a science-driven consensus document

describing a minimum suite of goals and metrics. A restored oyster reef should have a minimum of 15 oysters and 15 grams of biomass per square meter covering at least 30% of the reef, with at least two year classes of oysters on each reef.² The document was formally adopted by the Executive Committee of the SFGIT in December 2011.

In 2014, the CBP adopted a new Watershed Agreement http://www.chesapeakebay.net/documents/FINAL_Ches_Bay_Watershed_Agreement.withsignatures-Hires.pdf. One of the Sustainable Fisheries outcomes is to restore oyster reefs in 10 tributaries by 2025. To date, six tributaries have been selected for oyster restoration, Harris Creek, the Little Choptank River and Tred Avon River in Maryland and the Lynnhaven, Lafayette and Piankatank rivers in Virginia. The restoration projects are a joint effort among the state agencies (MDNR & VMRC), NOAA, ACOE, ORP, local organizations and consulting scientists.

Stock Status

The oyster stock in the Chesapeake Bay is estimated at less than 1% of its historic abundance. However, the oyster population has improved over the last few years. The 2013 Maryland oyster biomass index (a measure of relative oyster abundance and weight) increased to 2.09 and is at its highest value since the index started (1993) (Figure 1). The 2013 spatfall index was 22.7 spat/bushel, slightly above the long-term (29 yr) median index of 20.1 spat/bushel (Figure 2). The spatfall index is a measure of reproductive success and an index of potential population increase¹. Approximately 1.2 billion hatchery-raised oyster larvae produced by the University of Maryland Center for Environmental Science, Horn Point Laboratory, were planted in the Bay in 2013 to augment natural reproduction.

Two oyster parasites, *Perkinsus marinus* (Dermo) and *Haplosporidium nelsoni* (MSX) are major factors that impact oyster survival and population growth. The distribution and abundance of both diseases are influenced by environmental factors, especially temperature and salinity, and can vary from year to year. During 2013, the prevalence (percentage of oysters with the disease) of Dermo disease was 57%, below the 24-year average with a mean infection intensity of 1.9 (close to the average). MSX continued at low levels, mainly as a result of unfavorable lower salinities. As a result, total oyster mortality during 2013 was relatively low at 8%¹.

Pre-stock assessment studies were conducted in 2009-2010. The studies included a spatial analysis to determine the appropriate scale for oyster population processes and the development of two oyster stock assessment models. The models were fitted to harvest data from the fishery and relative density data from the fall dredge survey. The models estimated abundance and mortality rates. Both approaches found a substantial decrease in oyster abundance during the study periods³. Recommendations were made to improve data collection from the fishery and the fall survey. Maryland DNR has addressed some of the recommendations by

requiring more accurate harvest data (catch & effort). For the fall survey improvements have been made by recording catch by individual tow; by random subsampling; by accurately counting the number of individuals and assigning size classes; and by recording changes in habitat.

Current Management Measures

There are three concurrent approaches to managing oysters in the Chesapeake Bay: ecological restoration; a sustainable public fishery; and aquaculture. Ecological restoration will meet the goal of the Chesapeake Bay Program's new Watershed Agreement to restore oysters to 10 tributaries by 2025. Harris Creek was selected as the first restoration area. The target for Harris Creek is to restore 377 acres. To date, 188.6 acres have been restored and 1.2 billion oysters have been placed in Harris Creek. It is projected to take 2 to 5 years to complete the restoration effort if funding is kept at current levels. The Little Choptank River has been selected as the next priority area for targeted oyster restoration in Maryland. The governor has proposed a \$7.5 million capital investment in oyster restoration in Harris Creek (Talbot County) and the Little Choptank (Dorchester County) with additional money for aquaculture infrastructure improvements. The Tred Avon has been selected as the third area.

Maryland's oyster harvest has been around 100,000 bushels annually since 2002. Historically, the annual harvest averaged 2.5 million bushels (1920-1969) and 1.3 million bushels (1970-2002) (Figure 3). Preliminary harvest for the 2013-2014 season is 400,000 bushels. Both harvest seasons and catch limits by gear type are enforced for the public fishery. The sanctuary expansion allows 167,720 acres of natural oyster bars for the wild oyster fishery. Maryland DNR began implementing a new procedure for tagging each container (bushel) of oysters during the 2011-2012 oyster season. The new procedure follows the requirements by the National Shellfish Sanitation Program to protect human health.

New shellfish legislation was passed in 2011 and included expanding leasing areas; giving DNR the authority to revoke commercial licenses for poaching violations; transferring the Seafood Marketing and Aquaculture Program from the Department of Agriculture to the Department of Natural Resources; and requiring the Department of Environment to use the most reliable data to determine whether shellfish production areas pose risks to consumer health. A \$2.2 million financial assistance program was established to aid watermen in aquaculture endeavors. An aquaculture training and education program is also underway. The program includes a series of training publications and the sponsorship of two statewide aquaculture conferences. To date, there are 309 active lease areas that cover 3,782 acres. Preliminary 2013 harvest data from the leased areas were about 22,000 bushels. Maryland DNR has implemented an aquaculture electronic notification system for leaseholders. Beginning in 2013, leaseholders are required to submit monthly harvest reports.

Through a partnership with the Oyster Recovery Partnership, DNR provides field support for in-the-water activities of oyster aquaculture production.

The goal of Marylanders Grow Oysters (MGO), a program under Governor O'Malley's Smart, Green & Growing Initiative, is to engage waterfront property owners in growing young oysters in cages suspended from private piers. The young oysters are protected during their first year and then planted on local sanctuaries. The program has grown and planted about 6 million oysters in sanctuaries since it began in 2008. The program has grown from nearly 900 oyster cages to about 8,000 oyster cages, has involved about 2000 volunteers and has expanded to 30 tributaries. For more details on the program, go to the website <http://www.oysters.maryland.gov>.

Issues/Concerns

A major issue for oyster recovery is the continued degradation and loss of habitat. Approximately 80% of oyster habitat has been lost over the last 25 years². Maryland DNR believes at least 10,000 acres of habitat need to be rehabilitated for oyster recovery. In addition, a healthy and robust oyster resource in the Bay relies on appropriate substrate for the setting of young oysters. In 2013, Maryland purchased over 2700 tons of oyster shell from Florida as part of the restoration efforts in Harris Creek. Another 112,500 tons of shell are expected to be shipped during 2014. In addition to placing shell in Harris Creek, the shell will be used in the Little Choptank River. The Oyster Recovery Partnership has developed the Shell Recycling Alliance, a group of over 150 restaurant owners, caterers, seafood distributors and citizens, as a mechanism for collecting shells for habitat and seed. Starting in July, 2013, residents and businesses can receive a tax credit per bushel of recycled oyster shell up to \$750 per year.

The increase in sanctuary areas and aquaculture activities require additional law enforcement. New measures have been adopted to deter and issue citations for oyster poaching. Natural Resource Police (NRP) are using the Maritime Law Enforcement Information Network (MLEIN). The network is a system of cameras and radar units that can track and monitor vessel location and movements. Although this system was primarily set-up to provide homeland security and assistance to distressed boaters, it allows NRP to gather and store evidence of illegal activity especially in sanctuary areas. MLEIN has resulted in more arrests and more convictions of poachers than in previous years. A new penalty system has resulted in license suspensions and revocations.

References

¹Tarnowski, M. 2014. Maryland Oyster Population Status Report 2013 Fall Survey. Maryland Department of Natural Resources Shellfish Division & Cooperative Oxford Laboratory,

² Report of the Oyster Metrics Workgroup. 2011. Restoration Goals, Quantitative Metrics and Assessment Protocols for Evaluating Success on Restored Oyster Reef Sanctuaries. Submitted to the Sustainable Fisheries Goal Implementation Team of the NOAA Chesapeake Bay Program, Annapolis, Maryland.
http://www.chesapeakebay.net/channel_files/17932/oyster_restoration_success_metrics_final.pdf

³ Wilberg, M. and T. Miller. 2010. Developing Spatially-Explicit Assessment Tools for Eastern Oyster in Chesapeake Bay. Technical Report No. TS-599-10 of the University of Maryland Center for Environmental Science.

Figure 1. Maryland oyster biomass index, a measure of relative oyster abundance and weight, 1993 - 2013. (MDNR Fall Survey Report, 2014)

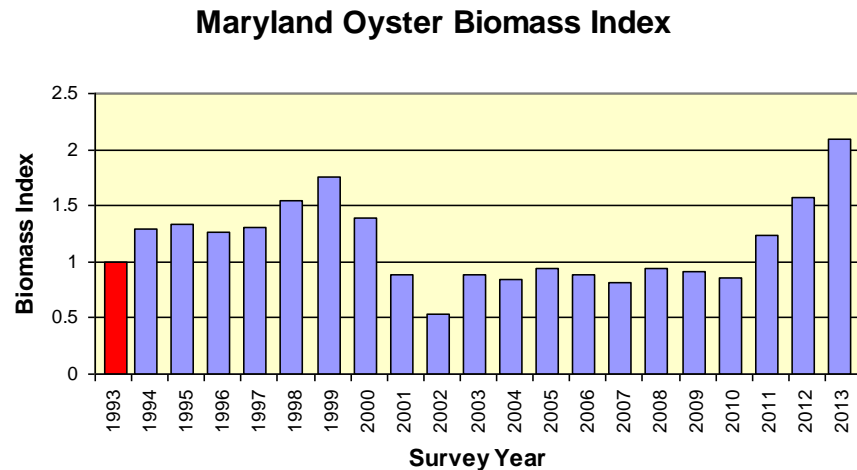


Figure 2. Maryland spatfall intensity index (spat per bushel) from "key bars" including rankings of statistically similar indices, 1985-2013 (MDNR Fall Survey Report, 2014). The statistical tiers provide an indication of the extent and contribution of spat from different geographic areas. To illustrate: although the 1997 spat index was the second highest index on record and an order of magnitude higher than other Tier 3 indices, it was a Tier 3 level because only 5 out of 53 key bars accounted for over 75% of the index.¹

Spatfall Intensity Index, 1985-2013

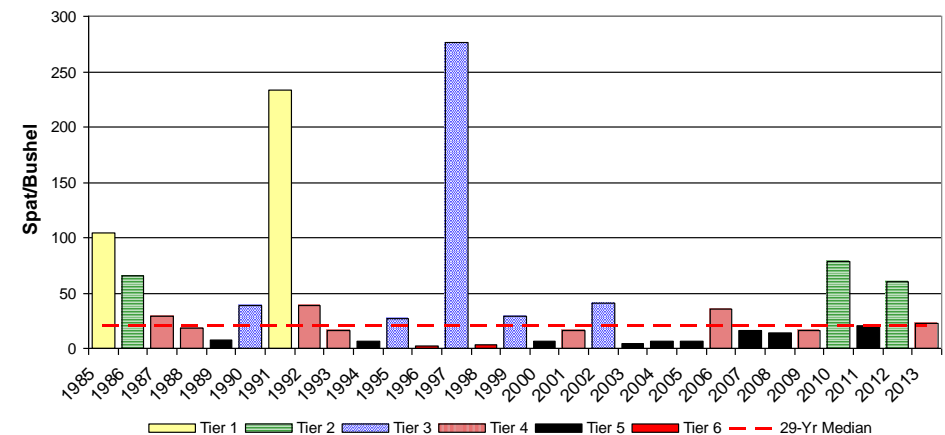
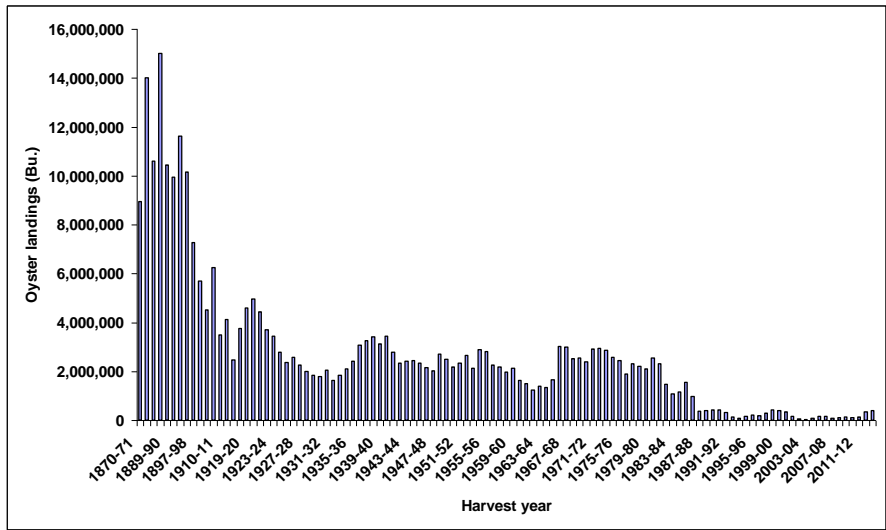


Figure 3. Maryland commercial oyster harvest, 1870 - 2014*



*Preliminary landings 2013-14

2004 Oyster Management Plan (OMP) Implementation Table (updated 9/2014)			
Section	Action	Date/ Responsible agencies	Comments
<p>Disease Strategy</p> <p>3.1A. Utilize disease management in all aspects of restoration & harvest to minimize spreading disease</p> <p>3.1B. Develop & implement disease strategies within each of the 3 designated salinity zones.</p>	<p>3.1 Conduct an analysis of how disease management might affect overall survival and productivity. Answer the following question: What management strategies will help increase biomass over a large scale and in the long-term?</p>	<p>Continue Univ. of MD, VIMS, MDNR, and VMRC.</p>	<p>Modeling and assessment frameworks were utilized through the EIS process to evaluate the benefits of disease management strategies. They included developing and testing of disease tolerant strains for aquaculture; implementing geographically distinct, large-scale oyster restoration (VIMS/NOAA funding); and producing disease-free spat on shell (ORP/UMCES). Scientific research results indicate the need for a cautionary approach to using disease resistant strains for restoration (see Action 6.3.1). Maryland has adopted a new approach for managing against oyster disease. Maryland will use a targeted restoration approach to facilitate the evolution of natural disease resistance, while managing against the spread of disease. Sanctuaries located in areas with salinities >14 ppt will encourage the development of disease resistance through natural selection.</p>
	<p>3.2 Increase hatchery production to supplement natural recruitment and mitigate the prevalence of <i>P.marinus</i> (refer to Chapter VI Hatchery Production for additional details)</p>	<p>Continue Univ. of MD, VIMS, MDNR, aquaculture industry</p>	<p>Additional State and Federal funding has resulted in an increase in hatchery production from 38 million spat in 2000 to over 1.2 billion in 2013. Over the years hatchery production has increased: 750 million spat (2009); ~450 million spat (2010); over 600 million spat (2011); over 800 million spat (2012) and 1.2 billion spat (2013). Production is dependent on spawning success in the hatcheries, availability of cultch, and long-term funding to operate the hatcheries at full capacity. VIMS started an Oyster Aquaculture Training program to provide skilled technicians in oyster husbandry for both hatchery and field operations. ORP has supported UMCES hatchery infrastructure and capacity (MDNR/NOAA funding).</p>
	<p>3.3 Establish broodstock sanctuaries in heavily infected areas to possibly produce disease resistant seed. (see Chapter IV Sanctuaries for more details).</p>	<p>Open MDNR, VMRC, ORP, VA Corps</p>	<p>Sanctuaries have been established in a variety of areas throughout the Bay to produce self-sustaining populations of oysters.</p>
	<p>3.4 Develop, implement and maintain a seed policy to reduce and minimize disease impacts.</p>	<p>2004 2007 Continuing</p>	<p>MDNR developed a new policy with additional restrictions, however, beginning in 2007 no seed was available to move and very little was moved in 2008 & 2009 to the present. VIMS has a long standing advisory to the state (VMRC) against moving diseased seed. Both MD & VA have oyster advisory committees to provide advice on seed policy issues as they arise.</p>
	<p>3.5 Implement oyster surveys as necessary to obtain the best estimates of oyster population data: a) Increase the frequency & spatial intensity of sampling; b) Seek additional funding.</p>	<p>On-going</p>	<p>MDNR funded a project (UMCES) to develop spatially-explicit assessment tools for the oyster stock in Chesapeake Bay. The project evaluated current data collection, recommended improvements to data collections and evaluated the feasibility of including environmental factors into assessment models. A final report was completed in 2010 and available at http://www.dnr.state.md.us/irc/docs/00016171.pdf. DNR/ MGS & NOAA are continuing to coordinate field operations to characterize benthic habitat.</p>

<p>Sanctuaries</p> <p>Strategy 4.1 A network of clearly marked oyster sanctuaries will be established throughout the Chesapeake Bay and its tributaries</p> <p>Strategy 4.2. Utilize the steps outlined in the OMP for establishing oyster sanctuaries throughout the bay.</p>	<p>4.2.1 Decisions on where to locate sanctuaries will be guided by the Virginia Oyster Restoration Plan developed by VIMS and VMRC and Maryland's Priority Restoration Areas developed by MDNR and the Maryland Oyster Roundtable Steering Committee. The maps will be used as a preliminary tool to focus restoration activities (The MD Oyster Roundtable has been replaced by the Oyster Advisory Committee)</p>	<p>2004 2009 On-going</p>	<p>MDNR supported a study to determine the best productive oyster bars within Maryland and used the results to develop a 10 point Oyster Restoration and Aquaculture Development Plan. Based on this study, new sanctuaries areas have been established. USACOE conducted a study to evaluate 63 tributaries and sub-regions for the purpose of supporting restoration. Six tributaries have been selected for oyster restoration, Harris Creek, the Little Choptank River and Tred Avon River in Maryland and the Lynnhaven, Lafayette and Piankatank rivers in Virginia Initial efforts have been focused on Harris Creek in Maryland and the Lafayette River in Virginia.</p>
	<p>4.2.2 Utilize existing protocols & standard operating procedures for recording or charting GPS coordinates for oyster sanctuaries in order to verify locations and track restoration progress.</p>	<p>Beginning in 2005 2008/2009 On-going</p>	<p>Protocols have been developed to delineate and mark sanctuary areas. Bay jurisdictions continue to track restoration progress.</p>
	<p>4.2.3 Evaluate the use of alternative cultch material because all restoration efforts depend on the availability of suitable habitat and traditional shell dredging cannot support the scale of the current & future sanctuary initiative.</p>	<p>On-going</p>	<p>A study on alternative cultch material in MD was conducted in various salinities & the report is on file with DNR. VIMS and the ACOE released a report on the effectiveness of alternative materials (2006). The function of alternative substrates is to provide a firm base for a constructed oyster bar. Alternate materials to replace natural oyster shell can be expensive. MDNR Shellfish Program spent over \$2 million on transporting 2,750 tons of shell from FL during 2013. They also will be considering buried shell deposits within the Bay.</p>
	<p>4.2.4 Develop and implement techniques to locate and recover buried shell or shell with layers of sedimentation using vacuuming, bar cleaning or other innovative methods.</p>	<p>2005 2009 On-going</p>	<p>MD has obtained a permit for a reclamation program that will provide up to 25 million bushels of shell. The MDNR/MGS and NCBO bottom survey program will provide information to prioritize areas and facilitate decisions on shell reclamation techniques. ORP started a Shell Recycling Alliance and collected approximately 15,000 bushels of shell in 2012. Beginning in 2013, a tax credit up to \$750 is allowed for recycling oyster shell.</p>
	<p>4.2.5 Increase hatchery production to support restoration needs. Current seed levels are too low to effectively stock sanctuaries (see Chapter VI Hatchery and Aquaculture).</p>	<p>2005</p>	<p>See comment for Action 3.2. The question of what is an effective quantity of hatchery seed in sanctuaries is unknown.</p>
	<p>4.2.6 Monitor areas to evaluate oyster population status and measure progress towards the commitment to increase oyster biomass by 10-fold.</p>	<p>On-going MDNR, VIMS</p>	<p>Utilize the 1994 value as the baseline for measuring the increase in biomass. Provide annual updates. Documentation for MD's methodology for calculating biomass estimates is available in the PEIS. Maryland's biomass is based on the annual fall survey data and an estimate of available oyster habitat. There is a need to improve the data, especially the habitat estimates, that supports the biomass calculations. Criteria for determining a restored oyster reef were adopted in 2011. Jurisdictions are focusing on restoring targeted tributaries, Harris Creek, Little Choptank and the Tred Avon (MD) and the Lynnhaven, Lafayette and Piankatank rivers (VA).</p>

<p>Sanctuaries (cont'd)</p> <p>Strategy 4.3 Management actions within sanctuaries are primarily based on salinity zones and focus on three key factors: growth, reproduction and disease. The zonal approach to management provides general guidelines for selecting project objectives and anticipating project results in each area</p>	<p>Strategy 4.3.A: Zone 1 (5ppt to <12ppt) Increase biomass & enhance reef habitat. Enhance reef/ bottom habitat to increase oyster biomass and promote the development of living oyster reefs with broad size/age class structure that supports a diverse reef community</p> <p>Action 4.3.A.1 Identify priority areas in Zone 1 that would have the most success at reaching the defined project objectives</p> <p>Action 4.3.A.2 Rehabilitate and maintain oyster bottom habitat to provide planting substrate for seed oysters and optimal conditions for larval settlement</p> <p>Action 4.3.A.3 Plant hatchery produced SPF seed, if necessary, over several years to establish an oyster population with a diverse age class structure</p>	<p>2005 On-going</p>	<p>MD is implementing a 10-Point Oyster Restoration Plan that focuses on targeted restoration strategies, expands the sanctuary program, rehabilitates oyster habitat, manages against disease, increases hatchery production, and enhances law enforcement.</p>
	<p>Strategy 4.3.B: Zone 2 (12-14ppt) Transition Area: The boundaries of Zone 2 shift because of variations in rainfall and resulting salinity. Consequently, Zone 2 will exhibit fluctuations in spat settlement and disease mortality. Projects in this zone must utilize current environmental data during planning.</p> <p>Action 4.3.B.1 Critically examine long-term environmental conditions and develop relevant project objectives for sanctuaries in Zone 2.</p> <p>Action 4.3.B.2 In the areas that have predominantly Zone 1 characteristics, utilize Zone 1 guidelines and in areas that have predominantly Zone 3 characteristics, utilize Zone 3 guidelines.</p>		
	<p>Strategy 4.3.C (>14ppt) Develop Disease Tolerance: It is not certain that disease resistance can develop via a management approach in Zone 3. The strategy will be to promote the development of disease resistance where disease mortality is high</p> <p>Action 4.3.C.1 Reestablish and maintain bottom habitat for oyster spat settlement and growth of disease resistant adults</p> <p>Action 4.3.C.2 Monitor Zone 3 sanctuaries to determine the effects of disease mortality</p> <p>Action 4.3.C.3 Utilize Zone 3 as an area to test laboratory strains of disease resistant oysters</p> <p>Action 4.3.C.4 Limit the use of natural seed to sanctuaries in Zone 3. The use of natural seed in repletion areas is allowed as long as disease protocols are followed.</p>		

Sanctuaries (cont'd) Strategy 4.4 The jurisdictions will establish oyster sanctuaries to promote maximum ecological value	Action 4.4.1 Identify areas of special interest throughout the Bay, especially areas that may retain larvae (maybe auto-recruiting), and protect them using the sanctuary status	On-going	The Great Wicomico, Lynnhaven and Lafayette Rivers have been identified as areas of special interest in VA. MD has established sanctuaries based on protecting 25% of the state's most productive areas as identified by an analysis of the annual fall survey data. Harris Creek is Maryland's first targeted restoration area. To date, it has received over 700 million oysters on 188.6 acres. UMCES is developing a model to predict where oyster larvae will be transported throughout Harris Creek. This research will help identify optimal locations for restoration activities thereby, maximizing larval retention. Other areas designated for targeted restoration efforts are the Little Choptank and Tred Avon.
Strategy 4.5 Implement the actions described in chapter III to address disease problems. In addition, the jurisdictions will take further action to minimize the spread of disease	Action 4.5.1 Utilize only SPF hatchery seed in sanctuaries designated for oyster biomass accumulation, Zone 1 and Zone 2.	On-going	Two workshops held in 2007 provided guidance on the role of hatchery-based oysters used for restoration. Using domesticated strains has not improved survival or resulted in higher recruitment. Preserving local wild stocks is preferred since data suggests some level of natural disease resistance is occurring (VIMS). Recent monitoring results provide more evidence of disease resistance. Dermo disease was below the long-term average and MSX was at its lowest level since 1990. It is difficult to separate the effects of environmental conditions especially temperature and salinity from improved survival due to disease resistance.
	Action 4.5.2 Place hatchery seed on newly created sanctuary bottom and not on top of infected oyster populations in order to prevent rapid infection of the disease-free seed	On-going	
	Action 4.5.3 Continue to prohibit the movement of infected oysters from higher salinity waters onto newly or previously created sanctuaries in Zone 1		
Sanctuaries (cont'd) Strategy 4.6 To facilitate the enforcement of closed areas, especially sanctuaries, implement the following actions:	Action 4.6.1 Sanctuaries will be placed in geographically distinct areas with enough space to create a buffer zone between harvest and sanctuary areas to enable enforcement	Began in 2003 and continue	State agencies are responsible for marking sanctuary areas but sanctuaries continue to experience enforcement problems. New enforcement strategies have been developed to address this issue. See strategy 5.4. During 2009, MDNR provided educational materials to the court system and implemented a pilot program in Anne Arundel County to establish a Natural Resource Day in court. This system has proven successful. MDNR also provided in-service training to NRP officers on all fishery issues especially regarding oysters. The use of MLEIN has led to more arrests and conviction than in previous years. The new penalty system has resulted in license suspensions and revocations.
	Action 4.6.2 Sanctuaries will be buoyed and marked		
	Action 4.6.3 The public and judiciary will be notified about sanctuary areas through educational initiatives, public announcements and stakeholder meetings		
	Action 4.6.4 New enforcement measures will be identified and implemented. Additional manpower will be recommended if necessary		
Managing Harvest Strategy 5.1 Establish sanctuaries & special management areas thereby reducing F & develop appropriate biological reference pts.	Action 5.1.1 Establish a network of sanctuaries (refer to Section 1.IV for details) and special management areas throughout the Bay to limit harvest and increase oyster production	Continue	The MD 10-pt Plan increased the total area designated as oyster sanctuaries from 9% of quality habitat in 2009 to approximately 25% in 2010. The plan allows approximately 167,720 acres of natural oyster bars for the wild oyster fishery. MD added 3 new sanctuaries that more than doubled the area of protected bottom from 1475 to 2581 acres. VA has a combination of 3-dimensional oyster reefs and acreage set aside as sanctuary areas. More than a 100 reefs have been constructed throughout VA's portion of the Chesapeake Bay.
	Action 5.1.2 Define appropriate biological reference points for the oyster resource based on the results of the bay wide stock assessment	2007/2008 2010	MD is working on developing BRPs. The 2010 assessment study indicated that exploitation rates have been around 25%. Assessments of oyster populations on specific bars are being conducted.

	Action 5.1.3 Utilize the disease guidelines and actions presented in Section 1.III in all aspects of special management areas and the fishery	2005	Continuing
	Action 5.1.4 Control oyster harvest to reach an appropriate F determined by the Oyster Scientific Committee.	2007/2008	Oyster harvest is controlled through a number of regulations by MDNR & VMRC. If BRPs are determined, a target and threshold F will be defined.
Strategy 5.2. Develop guidelines for managing fishing effort and monitoring oysters in open and closed areas.	Action 5.2.1 a) Determine the criteria for opening and closing areas; b) Monitor population; c) Determine level of acceptable exploitation; d) Regulate harvest and gear type; e) Develop additional monitoring if necessary; f) Close area when harvest criteria are met.	2005 On-going	Criteria for opening/closing harvest reserves have been developed. The managed reserves are opened to harvest only upon approval by the State and when 50% or more of the oysters are 4" in size. The 4" size limit allows the oysters an additional year to provide ecological services.
	Action 5.2.2 Utilize the site selection criteria set forth in the OMP to select special management areas (see Section 2 for details).	2005 Continuing	All oyster partners are managing oysters according to the salinity zones specified in section 2. Zone 1 (5-12 ppt) management involves the enhancement of populations by the planting of shell and seed. Zone 3 (>15 ppt) management involves the development of disease-resistant natural populations as well as the maintenance of hard substrate for spat settlement. Zone 2 (12-14 ppt) involves a mixture of these approaches.
	Action 5.2.3 a) MDNR will utilize the ORT STAC to review & make recommendations on where to locate harvest reserve areas; b) VA will utilize their current system to review and make recommendations on open & closed areas.	Continue 2007	The ORT STAC is no longer active. In 2007, MD established an Oyster Advisory Commission (OAC) to develop new strategies for rebuilding and managing the oyster resource. The OAC's recommendations resulted in MD's 10 point oyster management. The plan includes increasing the area and number of sanctuaries, encouraging aquaculture, and the support of a more targeted, sustainable, scientifically-managed oyster fishery.
	Action 5.2.4 Identify and implement regulatory & legislative changes needed for managing open & closed harvest areas.	2006	MDNR opens and closes areas via public notice. VMRC utilizes the Commission process.
	Action 5.2.5 a) Evaluate how rotating open & closed areas contributes to reproduction, oyster biomass & harvest; b) Based on the harvest reserve biological data, reevaluate the criteria (Action 5.2.1) for opening & closing areas & modify actions as necessary.	2005 On-going	Monitoring is underway and evaluation is on-going.
Strategy 5.3 a) Follow project guidance criteria specified in section 2 when developing repletion program work plans; b) Maintain the MDNR work plan review process	Action 5.3.1 Modify the MD repletion program through the established ORT Steering & Scientific Committees to reduce and minimize disease impacts: a) Establish criteria to limit and/or restrict seed movement to certain regions depending on environmental conditions & disease levels; b) Avoid transplanting older year classes that have higher levels of disease than young spat; c) Rotate and/or clean seed areas; d) Allow old seed areas to lie fallow and/or be harvested; e) Utilize the disease results from the Fall survey; f) Transplant wild seed as soon as possible.	2004 On-going	MDNR no longer implements a repletion program but puts all of its resources into the 10-point plan.
	Action 5.3.2 MD will evaluate the effects of the repletion program on oyster population dynamics and habitat; and document how it contributes to an increase in oyster biomass & habitat.	2006	No repletion effort currently in progress.
Strategy 5.4 Strengthen the enforcement of oyster closures in sanctuaries & special management areas.	Action 5.4.1 Evaluate and implement the appropriate enforcement measures.	2005 MNDNR, VMRC 2010	The MD Natural Resources Police (NRP) has begun to utilize the radar and camera vessel monitoring technology. The system, Maritime Law Enforcement Information Network (MLEIN), is largely a national security tool that has been adapted to aide enforcement.

	Action 5.4.2 Prohibit the culling of oysters while underway to minimize the movement of infected oysters.	On-going MDNR, VMRC	
Hatchery and Aquaculture Considerations Strategy 6.1 Utilize hatchery-produced seed to augment natural reproduction reduce disease effects & increase biomass.	Action 6.1.1 Develop an interlab certification program for oyster diseases. Utilize the molecular diagnostic protocols for certifying SPF oyster seed developed by the VIMS Shellfish Pathology Laboratory.	2005	Program was completed and currently used by VIMS, Univ. of MD, and MDNR.
	Action 6.1.2 MD will increase hatchery production of SPF seed to support the 10-fold increase in oyster biomass: a) Increase & maintain as necessary the operating funds for each MD hatchery facility; b) Evaluate & optimize the efficiency of each facility in order to ensure maximum production of spat.	On- going MDNR, ORP, UMD	See comments for Action 3.2
	Action 6.1.3 Continue the protocol for certifying and using SPF seed: a) establish standards & refine criteria; b) use only SPF seed in sanctuaries located in Zone 1 (< 12ppt).	Continue VIMS, MDNR, UMD	Implemented and continuing.
	Action 6.1.4 The U.S. Army Corps of Engineers (COE) will conduct an analysis of hatchery project production in relationship to environmental benefits as part of its long-term restoration planning, and determine whether augmenting or building new hatchery (ies) is warranted	2008 ACOE	The master plan examines and evaluates the problems and opportunities related to oyster restoration and formulates a plan for implementing large-scale Baywide restoration. This action was expected to be addressed as part of the Native Oyster Master Plan by the ACOE. However, the plan establishes guidelines for restoration and not specific actions.
Hatchery and Aquaculture Considerations (cont'd)	Action 6.1.5 Virginia will increase hatchery production of disease resistant seed to support the 10-fold increase in oyster production: a) Increase and maintain as necessary, the operating funds for oyster breeding in Virginia; b) Evaluate the feasibility of a public or a public-private hatchery	On going VMRC, VIMS	VIMS/VMRC conducted a pilot project to promote capacity building of private hatchery and grow-out infrastructures in order to provide oyster spat-on-shell for restoration (NOAA funding FY04 continued in FY06). VIMS is currently training oyster technicians for aquaculture work both in the hatchery and in the field.
	Action 6.1.6 Virginia will develop strategies for effective seeding of reefs and their effects on recruitment, especially in relation to the spread of disease resistance in the wild population.	2005 VMRC, VIMS	VIMS is conducting research on these questions through NOAA funding.
Strategy 6.2 Continue to track the genetic background of broodstocks used in hatcheries for restoration or replenishment activities	No specific actions recommended at this time.	To be determined MDNR, VMRC	There is some concern about reduced genetic variability of selectively bred oysters compared to wild oysters. In 2007, oyster disease experts recommended to discontinue transplanting infected natural seed; to discontinue bar cleaning for disease; to use hatchery-produced seed for augmenting natural stocks; to create sanctuaries and enforce a harvest moratorium; and consider larval dispersal mechanisms when creating oyster sanctuaries.

Strategy 6.3 Develop recommendations for using disease resistant strains of native oysters for restoration. Selectively bred oyster strains should be used for restoration only in areas where native oysters are locally depleted.	Action 6.3.1 Assess and evaluate the use of disease resistant stocks as a tool for increasing disease resistance in the native oyster population in the Bay.	2007	The participants at the 2007 OMP Workshop concluded that the development of alternative strains for use in restoration should not be pursued thereby preserving the natural ability of oysters to develop disease resistance. There was also consensus that domesticated disease-resistant strains were acceptable for aquaculture endeavors.
	Action 6.3.2 Monitor restoration activities to clarify the interaction between selectively bred strains and wild stocks of oysters.	2005 UMD, ORP, VMRC	Carlsson et al (2008) evaluated the contribution of a selectively bred, domesticated oyster strain to recruitment in the Great Wicomico, Lynnhaven, York, and Elizabeth Rivers from 2002 to 2006. They were unable to detect a significant contribution of the domestic strain to wild-produced spat.
Strategy 6.4 The members of the OMP drafting team will review the MD task force report & recommend changes to the OMP as appropriate regarding aquaculture strategies & actions	Action 6.4.1 Amend the OMP as necessary to incorporate new strategies and actions regarding aquaculture.	2009 2010	The vision of the new Maryland 10-Point Oyster Plan is “to establish a private aquaculture industry that emerges as a major economic contributor to the State of Maryland while maintaining a more targeted and scientifically managed wild oyster fishery that is sustainable.” Chapter 173 of the Legislative Acts of 2009 passed new aquaculture leasing statutes that completely changes how Maryland regulates, administers, and manages aquaculture and leasing of shellfish. Grants have been secured to help watermen with start-up and operational costs for new oyster farms. The first Aquaculture Enterprise Zone (AEZ) was established by regulation in October 2009 in the Patuxent River near Broomes Island. Amendment #1 to the OMP was adopted in 2010. The amendment allows aquaculture and clamming activities within the larger, expanded sanctuary (areas closed to shellfish harvest and focused restoration activities) program; the use of new enforcement measures to protect sanctuary areas; and the implementation of sanitation guidelines. During 2010, the OMP was reviewed. The PRT recommended that the plan be revised. The OMP is scheduled for a management meeting in 2014 to determine how to address the PRT recommendation.
Monitoring and Information Management Strategy 7.1 A) Utilize the results of the oyster stock assessment as an estimate of oyster abundance in the Bay; B) Use the 1994 biomass value as a baseline to track progress towards the 10-fold objective.	Action 7.1.1 Conduct monitoring programs that are consistent in terms of sampling procedure, timing of sampling, types of data collected, and analysis and provide the results to a central database or databases.	Continue	Monitoring programs have been reviewed. UMCES has provided recommendations on how to improve existing fishery-independent and fishery-dependent data collection methodology. MDNR Shellfish Program has taken the recommendations under consideration.
	Action 7.1.2 Establish a Technical Committee to develop data management guidelines for handling oyster data.	2005	Original committee meeting did not result in specific guidelines.

	Action 7.1.3 Develop and maintain a database to track oyster restoration projects and provide web-based access.	open MDNR, VMRC, NOAA	NOAA compiled an inventory of all oyster restoration project implemented in recent years in both states (2007). NOAA also established a full database of implementation and monitoring data for all oyster restoration projects completed with federal funding, beginning in FY07 and ongoing.
	Action 7.1.4 The Chesapeake Bay Program will conduct an annual oyster symposium		An Oyster Workshop was convened in December 2007.
	Action 7.1.5 Promote the research recommendations listed in Section 2.	2005 2009	All oyster partners. Research recommendations will be developed during the OMP revision process.

Acronyms:

ACOE = Army Corps of Engineers

BRPs = Biological Reference Points

CBP = Chesapeake Bay Program

MGS = Maryland Geologic Society

MDNR = Maryland Department of Natural Resources

MLEIN = Maritime Law Enforcement Information Network

NCBO = NOAA Chesapeake Bay Office

NOAA = National Oceanographic and Atmospheric Administration

OAC = Oyster Advisory Commission

OMP = Oyster Management Plan

ORP = Oyster Recovery Partnership

PEIS = Programmatic Environmental Impact Statement

PRT= Plan Review Team

SFGIT = Sustainable Fisheries Goal Implementation Team

SPF = Specific Pathogen Free

STAC = Scientific and Technical Advisory Committee

UMCEES = University of Maryland Center for Environmental & Estuarine Studies

UMCES = University of Maryland Center for Environmental Studies

VIMS = Virginia Institute of Marine Science

VMRC = Virginia Marine Resources Commission